Does footprint and foot progression matter for ankle power generation in spastic hemiplegic cerebral palsy?

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Conclusion

Deviation in the pedobarograph data are reflected in the power generation of the ankle joint. To some extent the two different investigations provide similar or at least related information on foot deformity and function. The pedobarograph being an easier and less expensive assessment tool can be used monitoring foot deformity and follow progress over time.

We speculate that by directing treatment towards normalizing heel segment pattern from the pedobarograph assessment, one can expect power generation differences to decrease.

Background

In cerebral palsy foot deformity develops over time and often need orthotic and surgical treatment. The foot influences the ankle, knee- and hip joint and therefore foot deformity and malfunction has an impact on the entire gait pattern. Pedobarograph which is the measurement of pressure distribution of the foot on the floor is together with three dimensional gait analysis often used in children with cerebral palsy. Both are dynamic and quantitative assessment tools on gait and although different they generate closely related information.

The purpose of this study was to investigate how footprint and foot progression relates to power generation from the ankle joint in children with spastic hemiplegic CP.

Material and Methods

Thirty-five children with spastic hemiplegic cerebral palsy, mean age 8.8 years (range 4.0-19.8) were included. All independent ambulators graded as children with spastic hemiplegic CP.

Gait analysis

The gait analysis was performed with a Motion analysis video capture system and all the data was reduced using OrthoDek (City, California). The patients walked at a self selected speed. The kinetic data was collected using two force plates (Advanced Mechanical Technology Inc. AMTI, Watertown, MA). Generally 3 trials from each foot were collected.

Pedobarograph

The pedobarograph, a Tekscan High-Resolution Pressure Assessment System (Tekscan, Inc., South Boston, MA, USA) was used. The pedobarographs were analysed by dividing the foot into five segments starting with the heel segment (posterior 1/3), the midfoot (middle 1/3) and forefoot anterior 1/3). The midfoot and forefoot was divided into symmetrical medial and lateral segments yielding medial midfoot (MMF), medial forefoot (MFF), lateral midfoot (LMF), and lateral forefoot (LFF). The pressure/time integral was normalised with the body weight and foot size, and the impulse, total pressure during one step, of each segment was calculated.

Results

First we compared all the patients included regarding differences between the hemiplegic and non-involved side as to assess usual differences found in the Gait analysis and Pedobarograph. Table 1.

Table 2: Comparison of Group 1 with less than 8 Watts/Kg in ankle power generation and group 2 with more than 8 Watts/Kg.

Bivariate correlation demonstrated a significant association for the hemiplegic side ankle power generation for the variables time to heel rise (r=0.374, p<0.005) and varus/valgus index (r=-0.420, p<0.017) and almost significant for heel pressure impulse (r=0.342, p<0.052).

References

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Background

In cerebral palsy foot deformity develops over time and often need orthotic and surgical treatment. The foot influences the ankle-, knee- and hip joint and therefore foot deformity and malfunction has an impact on the entire gait pattern. Pedobarograph which is the measurement of pressure distribution of the foot on the floor is together with three dimensional gait analysis often used in children with cerebral palsy. Three dimensional gait analyses provide information on movement and forces acting over the different joints. Both are dynamic and quantitative assessment tools on gait and although different they generate closely related information. The purpose of this study was to investigate how foot pressure pattern and foot progression relates to power generation from the ankle joint in children with spastic hemiplegic CP.

Material and Methods

Thirty-five children, mean age 8.8 years (range 4.0-19.8), all independent ambulators were included. The diagnosis spastic hemiplegic CP is defined as unilateral neurological involvement registered on the physical examination with the typical upper and lower extremity positioning. Additionally gait deviations found in the kinematics and kinetic data on GA defines the diagnosis. All children were fully independent community ambulators graded as Gross Motor Function Classification System level one.

The gait analysis was performed with a Motion analysis video capture system and all the data was reduced using Orthotrak (City, California). The patients walked at a self selected speed and the Orthotrak marker system was routinely used to collect kinematic data on the hemiplegic and non-involved side. The kinetic data was collected using two force plates (Advanced Mechanical Technology Inc. AMTI, Watertow, MA). Generally 3 trials from each foot were collected. To collect and analyze the data for the pedobarograph, a Tekscan High-Resolution Pressure Assessment System (Tekscan, Inc., South Boston, MA, U.S.A) was used.

The pedobarographs were analysed by dividing the foot into five segments starting with the heel segment (posterior 1/3), the midfoot (middle 1/3) and forefoot (anterior 1/3). The midfoot and forefoot was divided into symmetrical medial and lateral segments yielding medial midfoot (MMF), medial forefoot (MFF), lateral midfoot (LMF), and lateral forefoot (LFF). The pressure/time integral was normalised with the body weight and foot size, and the impulse, total pressure during one step, of each segment was calculated.

Results

On the hemiplegic side the mean power generation from the ankle was 7.6 Watts/kg, compared to the non-involved side 15.9 (p=.000). The pedobarograph data revealed significantly less heel pressure/impulse on the hemiplegic side 8.0 to the non-involved side 24.7 (p=.000) Time to heel rise differed as well, 32.1% of stance phase compared to 61.9% of stance phase (p=.000). The medial forefoot segment on the hemiplegic side had less pressure, 40.8, compared to the non-involved 52.2 (p=.009).

Bivariate correlation demonstrated a significant association for the hemiplegic side ankle power generation for the variables time to heel rise (r=0.574; p=.000) and varus/valgus positioning (r=0.420; p=.017) and almost significant for heel pressure/impulse (r=0.342; p=.052).

Conclusion

Deviations in the pedobarograph data are reflected in the power generation of the ankle joint and can be of help in decision making of treatment in spastic hemiplegic cerebral palsy. In conclusion we believe reliable and useful information can be gained from both the three dimensional gait analysis and the pedobarograph in children with cerebral palsy. To some extent the two different investigations provide similar or at least related information on foot deformity and function. The pedobarograph being an easier and less expensive assessment tool can be used monitoring foot deformity and follow progress over time. Presumably a more normal looking foot works better than a deformed.

References